Evaluation of urolithiasis complicating obstructive uropathy using duplex and spectral doppler ultrasound in association with non-contrast CT

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ABSTRACT

Introduction: A crystal cocentrate called a kidney stone usually formed inside the kidneys. It is a growing urological condition that has an impact on human health and affects 12% of the global population. End-stage renal failure has been linked to renal calculi.[1] Renal doppler is used to study the renal obstruction.

Aims and Objectives :

To evaluate the diagnostic utility of intrarenal arterial Doppler study in

ureteric obstruction.

To compare intrarenal arterial doppler in patients with obstructed and

non obstructed kidneys.

Materials and Methods:

Prospective case study of 50 patients presenting unilateral acute renal colic after taking ethical committee clearance. The side of kidney that is obstruction act as case and the opposite unobstructed normal kidney act as control.

 All cases undergo grey scale ultrasonography and Spectral ultrasonography using curvilinear low frequency 3-5 Hz transducer.

 Grey scale doppler is used to access pelvicalyceal system dilatation.

 Using spectral doppler to doppler reading is taken from interlobar arteries with sample width of 2-5 mm.

 RI is calculated by formula

RI= (peak systolic velocity - end diastolic velocity)/peak systolic velocity

 The delta RI will be determined as the difference in RI of the corresponding and contralateral kidney.

 For each kidney Average RI is calculated.

 upper limit of RI 0.70 is the of normal intrarenal resistance

 The average Resistivity Index (RI) in obstructed kidneys will compared with the contralateral normal kidney.

 Obstruction will be confirmed with ultrasound. If ultrasonography is equivocal CT scan will be done for confirmation of obstruction.

 The site of obstruction will be considered to be proximal, if it is up to or proximal to the L3 vertebral level and distal, if beyond.

Results: Resistivity Index (RI) value of obstructed kidney in segmental arteries of all the 50 cases was significantly more than the contralateral unobstructed kidney (0.75 vs 0.56; $p<0.001$) with a sensitivity of 90% and specificity of 98%.

Conclusion: We conclude that usefulness of Spectral doppler ultrasound in acute renal obstruction, thus we can avoiding unnecessary CT exposure of patients to ionizing radiation. This study has high sensitivity and specificity with RI value > 0.7 and comparable to other studies world wide.

Key words: Resistive index, kidney, CT, doppler.

ARTICLE

ROLE OF DUPLEX AND SPECTRAL DOPPLER ULTRASOUND IN EVALUATION OF UROLITHIASIS COMPLICATING OBSTRUCTIVE UROPATHY WITH ASSOCIATION OF NON-CONTRAST CT.

Ultrasonography is still a regularly used method for the first evaluation and diagnosis of renal blockage. It may accurately detect urinary system dilatation close to the degree of obstruction, which is an additional diagnostic sign. It is frequent to find slight pelvicalyceal system dilatation in certain patients with obstruction. In a small number of cases, ultrasonography may overlook renal obstruction if a blocked pelvicalyceal system is not dilated. Due to irregular calculus blockage, decompression of the pelvicalyceal system brought on by a rip in the calyceal fornix, poor diuresis brought on by dehydration, renal parenchymal disease at the underlying level, and the inability of the blocked pelvicalyceal system to expand. In the diagnosis of calculi, ultrasonography's sensitivity is significantly higher than its specificity. Ultrasound is less specific than excretory urography because it does a poor job of visualising the dilated ureter, evaluates upper tract drainage poorly, and lacks the functional data offered

by contrast medium excretion. One problem is that ultrasonography may reveal a collecting system that is fluid-filled, which isn't usually pathological but could be. These issues include an upper pole complicated calyx, an extra-renal baggy pelvis, and a second overextended bladder. Violent diuresis frequently reveals fluid within the collecting system after an excess of oral fluids. Similar situations can arise when an osmotic diuresis for urography is produced by an intravenous infusion of a hypertonic contrast solution.

Ultrasound is less specific than excretory urography because it does a poorer job of visualising the dilated ureter, performs a worse job of evaluating upper tract drainage, and does not provide the functional information that contrast medium excretion during urography does. Ultrasonography has the potential to reveal a collecting system that is fluid-filled, which isn't usually a sign of disease but could be. A second overextended bladder, an upper pole complicated calyx, and an extra-renal baggy pelvis are some of these abnormalities. When engaging in aggressive diuresis after consuming too much oral fluid, fluid within the collecting system is frequently visible. Similar situations can arise if a hypertonic contrast solution is injected intravenously to produce an osmotic diuresis for urography.

The kidneys lower blood flow is still present after 24 hours, but the pressure in the collecting system gradually recovers to normal. By using the resistive index and Doppler scanning ultrasound, obstruction may be observed to limit renal blood flow. [2,3,4] The pathophysiologically anticipated time course for the RI changes shows a peak between six and forty-eight hours after acute renal calculus blockage and a rise of about six hours thereafter. The RI is consequently enhanced but becomes less noticeable. [5,6,7,8,9,10,11,12,13]

AIMS & OBJECTIVES:

- To determine if an intrarenal arterial Doppler examination can accurately diagnose renal blockage.

- To assess the differences between individuals with obstructed and unobstructed kidneys using intrarenal arterial doppler.

- To evaluate urolithiasis by CT where ultrasound detection is not possible.

MATERIALS AND METHODOLOGY

A prospective study was conducted from February 2021 – December 2022 on 50 patients on patients presenting with unilateral renal colicky pain. Data for the study was obtained from patients attending department of Radiodiagnosis, Vinayaka Missions Kirupananda Variyar Medical College and Hospital, Salem.

INCLUSION CRITERIA include: all patients who report to the emergency room with unilateral acute renal colic and symptoms of acute renal obstruction.

EXCLUSION CRITERIA include: a) Patients with history of renal parenchymal disease, like renal trauma, bilateral renal obstruction, hypertensive and diabetic; b) Patients on dialysis; c) Patients having a single kidney, congenital anomaly of the kidneys.

The kidney on the side with blockage will be handled as the case kidney and the contralateral normal (unobstructed) kidney will be used as the control in the ultrasonography and Doppler evaluation. All patients will undergo USG and Duplex Doppler and Spectral Doppler in GE LOGIQ F8 Expert. On the gray-scale photographs, each kidney's presence or lack of pelvicalyceal system dilatation will be evaluated. Interlobar arteries at the boundary of the medullary pyramids will provide at least three Doppler spectra, and their means will be calculated. The lowest pulse repetition frequency that can be used to create Doppler waveforms without aliasing will be used. By doing this, the Doppler spectrum's size was maximised and the measurement's percentage error was reduced. Additionally, each

ultrasonic scanner will be equipped with its lowest wall filter. The width of the Doppler sample will be adjusted at 2–5 mm.

The renal RI will be calculated as follows:

(Peak systolic velocity- end diastolic velocity)/peak systolic velocity; the RI difference (delta RI) is calculated as the difference between the RIs of the homologous and contralateral kidneys. For each kidney, the mean RI value will be determined. If no calculus detected by ultrasound and RI vale is higher (>0.7) the patient is subjected to CT KUB.

Evaluation by Computed tomography

16 slice multi detector Computerized Tomography (GE Revolution ACTs) equipment will be used in this study. Non-enhanced CT of the abdomen will be performed extending from dome of diaphragm to iliac crest with 3mm spiral selections followed by 1.25 mm reconstruction. Factors given will be 120 kVp and 120 mAs. CT scan will used to detect pelvicalyceal system dilatation if any, the obstructing calculus and also its site of obstruction. If the blockage is up to or close to the L3 vertebral level, it will be deemed proximal; otherwise, it would be deemed distal. Patients whose blockage was not established by CT are not included in the study.

RESULTS-

The study was done on 50 cases presenting with unilateral renal colic pain in emergency department. All evaluated with grey scale B mode ultrasound, CDUS and PWDUS.

Kidney was assessed for pelvicalyceal dilatation and site of obstruction. The power doppler was applied to both kidneys (one act as control and other act as case). At least doppler

reading are taking in interlobar arteries along medullary pyramids with lowest repetition possibly without aliasing frequency and averaged.

In our study on 50 individuals, restive index was found to be elevated in obstructed kidneys when compared to unobstructed kidney (0.77 v/s 0.54). (Table 1, Figure 1).

The delta RI (difference in RI between obstructed and unobstructed kidney) was found to be ranging from 0.09-0.39 (AVERAGE delta RI = 0.24). (Table 1, Figure 1).

KIDNEY	**RESISTIVE INDEX**
OBSTRUCTED	**0.77-/+0.055**
UNOBSTRUCTED	**0.54-/+0.053**
DELTA RI	**0.24-/+0.078**

TABLE 1: RESISTIVE INDEX OF UNOBSTRUCTED V/S OBSTRUCTED KIDNEY

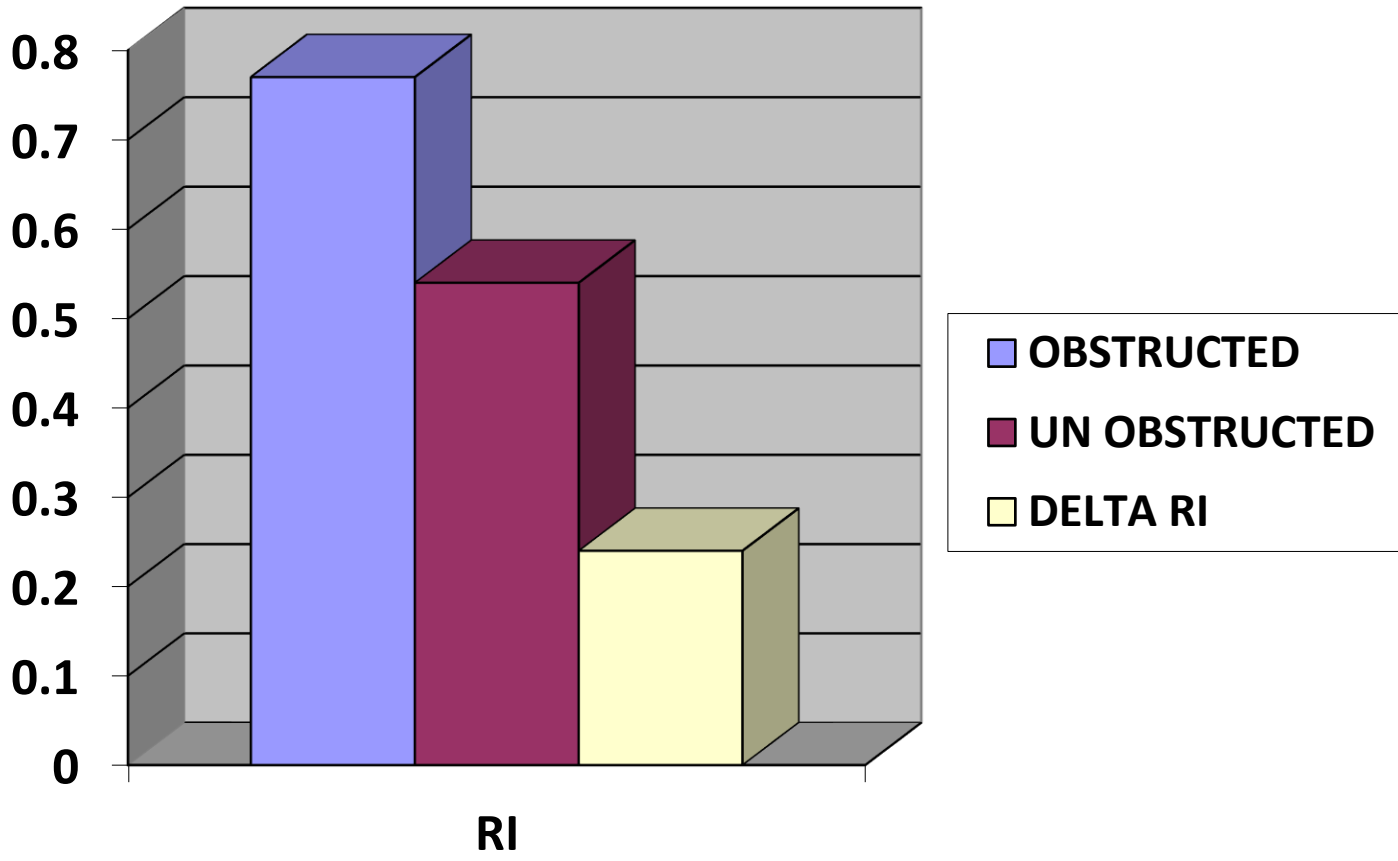

FIGURE 1 : RESISTIVE INDEX OF UNOBSTRUCTED V/S OBSTRUCTED KIDNEY

	FREQUENCY	MEAN RI	SD	P value
Obstructed	**50**	**0.7751**	**0.055037**	**0.001**
Unobstructed	**50**	**0.54**	**0.053404**	

Statistically significant (p value < 0.05)

TABLE 2: GROUP STATISTICS

Average RI value in obstructed kidney was 0.77 and unobstructed kidney was 0.54 was statistically significant.

	MEAN RI VALUE		**P value**
	<0.7	**>0.7**	
Obstructed	**2(4%)**	**48(96%)**	**0.003**
Unobstructed	**49(98%)**	**1(2%)**	

Statistically significant

TABLE 3: GROUP STATISTICS

DISCUSSION-

The role of doppler USG in acute renal calculi is controversial.

Platt J at el [14] showed significant effect on doppler USG as increased RI in obstructed kidney. Similar results were shown by Rodger et al [15]. Whereas Tublin et al [16] the sensitivity and specificity were only 44% and 82% for doppler USG, respectively.

In this study on 50 patients, we concluded RI in obstructed kidney was higher than unobstructed kidney significantly. The RI value was elevated in all cases of obstructed kidney. The delta RI difference in mean RI value of unobstructed and obstructed kidney was 0.24 , with delta RI range between 0.09-0.39. We showed level of obstruction had no statistically significant findings. (Table 2, Table 3). Our results matches with Badr K et al,

Amit, J. et al and Shokeir AA[17,18,19]. However, de Toledo et al [20] study showed proximal ureteric obstruction had higher RI.

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